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# BIOLOGICAL EVALUATION R10-90-4
# HAZARD TREE EVALUATION
# BIRD CREEK CAMPGROUND
# ALASKA DIVISION OF PARKS AND OUTDOOR RECREATION

NOVEMBER 1990

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## INTRODUCTION

Forested campgrounds throughout the State of Alaska historically have not been evaluated for hazard to campers. A technique to assess tree hazard specific to forested camprounds in south-central Alaska is currently under development. Personnel of Alaska State Parks requested Forest Pest Management Staff to undertake a hazard evaluation of Bird Creek State Campground. The purpose of the survey was to field test this technique and to identify hazard trees which have the potential to fail and cause damage to persons or property within the campground.

## METHODS

Each campground tree was systematically examined for defect and location to potential targets, should the tree fail. Trees were assigned numerical values using the following scheme:

| Category | Risk value |
|---|---|
| 1. Tree Species | |
| a. Hemlock | 1 |
| b. Spruce | 2 |
| c. Birch | 3 |
| d. Cottonwood, Aspen | 3 |
| 2. Potential Target | |
| a. None | 0 |
| b. Trails (low use), signs, etc. | 1 |
| c. Temporary Structures, Trails (high use) | 2 |
| d. People, Permanent Structures, Vehicles | 3 |
| 3. Defect Present | |
| a. No Visible Defect | 0 |
| b. Slime Flux | 1 |
| c. Small Mechanical Injury | 1 |
| d. Large Mechanical Injury | 2 |
| e. Frost Cracks | 2 |
| f. Lightning Scars | 2 |
| g. Bole Canker | 2 |
| h. Limb Defects | 2 |

| | |
|---|---|
| h. Limb Defects | 2 |
| i. Forked Tree | 2 |
| j. Dead Top | 3 |
| k. Dead Tree | 3 |
| l. Bole Canker (decayed) | 3 |
| m. Punky Knots | 3 |
| n. Conks | 3 |
| o. Basal Cavity | 3 |
| p. Butt Rot | 3 |
| q. Exposed Roots | 3 |
| r. Leaner (unnatural) | 3 |
| s. Root Rot | 3 |

For each tree greater than 20 inches diameter (d.b.h.), one additional point was assigned to the risk value. The highest risk value from each catagory was summed to give the overall tree rating. Overall tree ratings could range from 1 to 10. Trees with an rating of 1-4 are low hazard, 5-7 moderate hazard, and 8-10 high hazard.

Trees which had visible signs indicating heart rot were cored to determine the amount of sound wood.

## RESULTS AND RECOMMENDATIONS

Within the entire campground 76 trees were evaluated and mapped (Figure 1). Trees that need to be cut prior to the 1990 camping season to substantially reduce the risk of personal injury and property damage are listed in Table 1. These trees are high hazard and have potential targets which include people, permanent structures, and vehicles. Note, many of these trees have less than 2 inches of sound wood supporting the upper bole and crown.

Trees that could wait until 1991 camping season are listed in Table 2. These trees are moderate to high hazard and have potential targets that are temporary structures or high use trails. The risk to personal injury or property damage is less for these trees than those in Table 1.

Once the trees in Tables 1 and 2 are removed, wilding spruce can be planted as replacement for screening and aesthetic values. Hardwoods are not recommended near existing camping units because they are easily damaged by camp visitors. However, hardwoods can be planted in the background to provide some visual diversity.

Trees that should be monitored annually and removed if tree conditions deteriorate are listed in Table 3. These are trees that are moderate to high risk due mainly to having exposed roots and mechanical wounds. Because of the shallow soils in

Alaska, trees with exposed roots with no other signs of damage to the root system should be given a lower rating; a 1 instead of a 3. Though these trees appear to be sound, these trees should be examined annually for additional signs of damnage. Since the potential targets range from people to temporary structures, liablity could be high if a failure occurs.

Trees listed in Table 4 do not pose a serious threat to persons or property. However, to improve the overall health of the campground, they could be removed in the future. To reduce the impact of removal, wildlings could be planted near these trees. Once the wildlings become established, older trees can be removed. If strategically located, many of these trees could provide wildlife habitat for small animals and birds. Consideration can be given to girdling some trees and pushing over others to encourage wildlife use.

Healthy, fast growing trees are usually not attacked by bark beetles or seriously affected by tree diseases. It is considered good managmeent to keep trees in as vigourous a state as possible. Fertilization and thinning trees that are in crowded condition, will promote tree vigor and stimulate new root grouwth. This can be extremely important in older stand such as those in Bird Creek Campground.

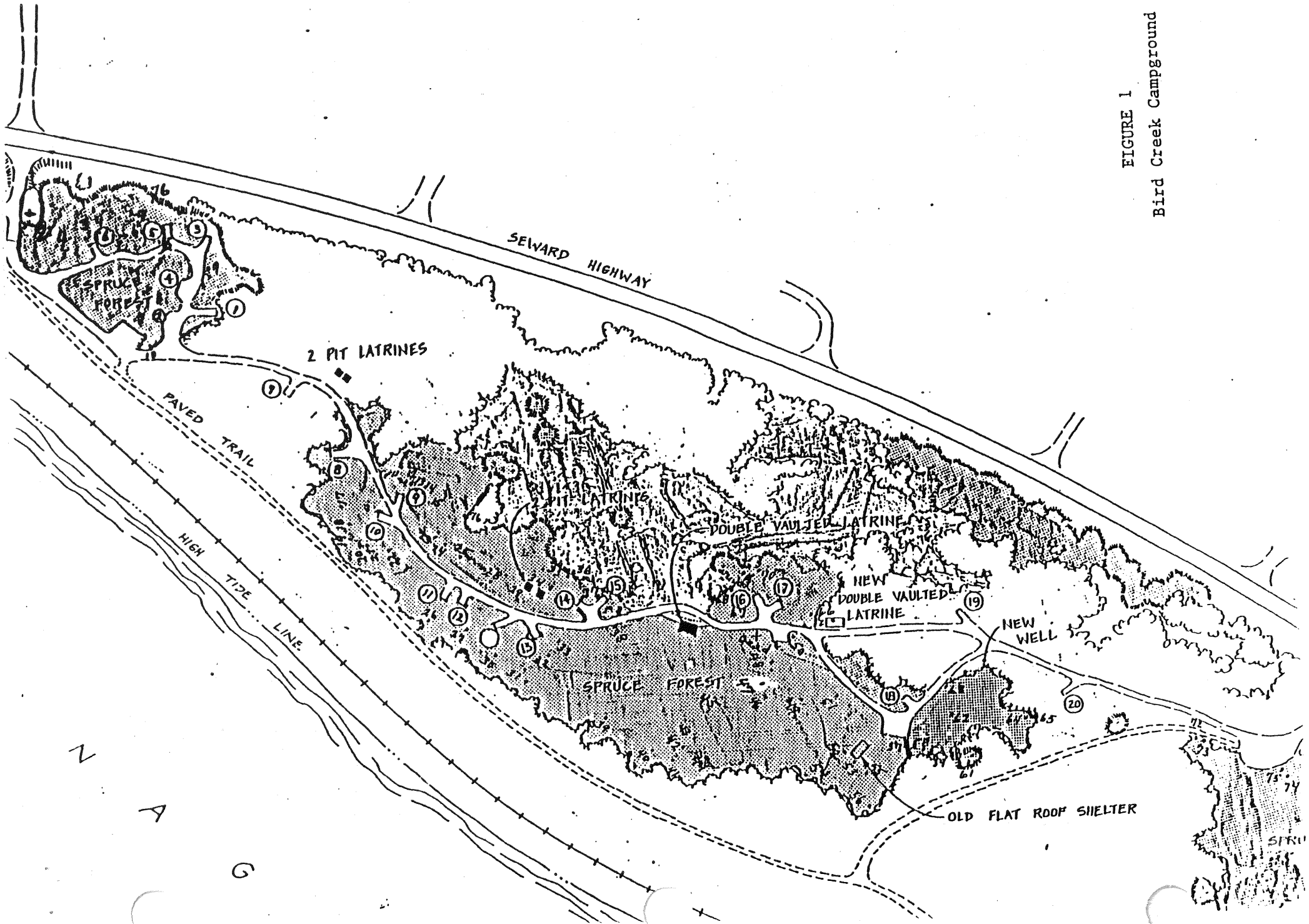


FIGURE 1

Bird Creek Campground

Table 1 -- Trees that should be removed prior to the 1990 camping season.

| MAP TREE NUMBER | SPECIES | REMARKS |
|---|---|---|
| 1 | Spruce | 30.4 inch d.b.h.; bole canker |
| 3 | Spruce | 20.0 inch d.b.h.; puncky knots; 3 inch sound wood |
| 4 | Spruce | 29.2 inch d.b.h.; conks; exposed roots |
| 5 | Spruce | 27.8 inch d.b.h.; butt rot; exposed roots; root rot; 1.5 inch sound wood |
| 6 | Spruce | 18.3 inch d.b.h.; dead top; butt rot; root rot; 1 inch sound wood |
| 7 | Spruce | 17.2 inch d.b.h.; conks; root rot; 1.5 inch sound wood |
| 8 | Spruce | 18.6 inch d.b.h.; dead top; butt rot; exposed roots; root rot; .5 inch sound wood |
| 9 | Spruce | 27.8 inch d.b.h.; bole canker; basal cavity; exposed roots; root rot |
| 10 | Spruce | 21.7 inch d.b.h.; bole canker; conks; butt rot; exposed roots; 2 inch sound wood |
| 11 | Spruce | 15.1 inch d.b.h.; exposed roots; leaner |
| 22 | Spruce | 30.9 inch d.b.h.; basal cavity; 1.5 inch of sound wood |
| 24 | Hemlock | 21.5 inch d.b.h.; conks; 2.5 inch sound wood |
| 25 | Hemlock | 22.9 inch d.b.h.; conks; leaner; 2.5 inch sound wood |
| 26 | Spruce | 27.5 inch d.b.h.; butt rot; exposed roots; root rot; 2.75 inch sound wood |
| 29 | Hemlock | 17.0 inch d.b.h.; conks; exposed roots |
| 32 | Spruce | 20.4 inch d.b.h.; butt rot; exposed roots; root rot |
| 35 | Spruce | 17.7 inch d.b.h.; exposed roots; root rot |
| 38 | Spruce | 13.3 inch d.b.h.; large mechanical wound; bole canker; leaner |
| 46 | Spruce | 21.5 inch d.b.h.; conks; exposed roots; .75 inch sound wood |
| 47 | Spruce | 16.3 inch d.b.h.; conks; exposed roots; leaner; 4.5 inch sound wood |
| 48 | Spruce | 16.2 inch d.b.h.; heart rot; 1.5 inch sound wood |
| 50 | Spruce | 30.1 inch d.b.h.; exposed roots; 2.5 inch sound wood |
| 51 | Spruce | 22.8 inch d.b.h.; bole canker; conks; root rot |
| 64 | Spruce | 23.6 inch d.b.h.; exposed roots; root rot |
| 66 | Spruce | 18.5 inch d.b.h.; exposed roots; root rot; 2 inch sound wood |
| 67 | Spruce | 24.3 inch d.b.h.; bole canker; butt rot; root rot; 1.25 inch sound wood |
| 69 | Spruce | 30.9 inch d.b.h.; bole canker; conks; exposed roots; root rot; 8.5 inch sound wood |
| 70 | Spruce | 25.8 inch d.b.h.; conks; butt rot; exposed roots; root rot; 4.5 inch sound wood |
| 76 | Spruce | 16.9 inch d.b.h.; root rot; 2.5 inch sound wood |

Table 2 -- Trees that should be removed prior to the 1991 camping season.

| MAP TREE NUMBER | SPECIES | REMARKS |
|---|---|---|
| 18 | Spruce | 17.8 inch d.b.h.; basal cavity; exposed roots; leaner; 3.5 inch sound wood |
| 28 | Spruce | 28.1 inch d.b.h.; conks; butt rot; 5 inch sound wood |
| 41 | Spruce | 18.9 inch d.b.h.; conks; butt rot; 1.25 inch sound wood |
| 44 | Spruce | 15.7 inch d.b.h.; butt rot; leaner |
| 45 | Spruce | 20.6 inch d.b.h.; bole canker; .5 inch sound wood |
| 49 | Spruce | 10.3 inch d.b.h.; bole canker |
| 56 | Hemlock | 10.0 inch d.b.h.; large mechanical wound; 50% cut through |
| 58 | Spruce | 9.3 inch d.b.h.; dead top; leaner |
| 63 | Spruce | 18.3 inch d.b.h.; frost cracks; leaner; 1.25 inch sound wood |
| 73 | Spruce | 13.5 inch d.b.h.; butt rot; leaner |

Table 3 -- Trees that should be monitored annually and removed if tree conditions deteriorate.

| MAP TREE NUMBER | SPECIES | REMARKS |
|---|---|---|
| 2 | Spruce | 33.0 inch d.b.h.; small mechanical wound; exposed roots |
| 12 | Spruce | 21.7 inch d.b.h.; large mechanical wound; exposed roots |
| 13 | Spruce | 17.5 inch d.b.h.; large mechanical wound; exposed roots |
| 14 | Spruce | 18.6 inch d.b.h.; large mechanical wound; exposed roots |
| 15 | Spruce | 18.1 inch d.b.h.; large mechanical wound; exposed roots |
| 17 | Spruce | 21.5 inch d.b.h.; large mechanical wound; exposed roots |
| 20 | Spruce | 21.2 inch d.b.h.; large mechanical wound; exposed roots |
| 21 | Spruce | 11.2 inch d.b.h.; large mechanical wound; exposed roots |
| 27 | Spruce | 22.1 inch d.b.h.; large mechanical wound |
| 30 | Spruce | 22.3 inch d.b.h.; large mechanical wound |
| 31 | Spruce | 15.9 inch d.b.h.; large mechanical wound; frost crack; leaner |
| 36 | Hemlock | 11.5 inch d.b.h.; large mechanical wound; exposed roots |
| 37 | Spruce | 17.8 inch d.b.h.; exposed roots |
| 52 | Spruce | 24.3 inch d.b.h.; large mechanical wound; exposed roots |
| 53 | Spruce | 21.4 inch d.b.h.; large mechanical wound; exposed roots |
| 54 | Spruce | 13.7 inch d.b.h.; frost cracks; exposed roots |
| 55 | Spruce | 22.5 inch d.b.h.; large mechanical wound; exposed roots |
| 57 | Birch | 9.8 inch d.b.h.; large mechanical wound; exposed roots |
| 71 | Spruce | 18.4 inch d.b.h.; large mechanical wound; exposed roots |
| 72 | Spruce | 21.0 inch d.b.h.; leaner |
| 74 | Spruce | 17.8 inch d.b.h.; forked tree; leaner |
| 75 | Spruce | 18.4 inch d.b.h.; leaner |

Table 4 -- Trees that could be removed at a later date to improve overall forest health.

| MAP TREE NUMBER | SPECIES | REMARKS |
|---|---|---|
| 16 | Spruce | 23.1 inch d.b.h.; basal cavity |
| 19 | Spruce | 24.1 inch d.b.h.; conks; leaner |
| 23 | Hemlock | 16.0 inch d.b.h.; conks; leaner |
| 33 | Spruce | 15.6 inch d.b.h.; large mechanical wound; exposed roots |
| 34 | Birch | 16.0 inch d.b.h.; bole canker; conks |
| 39 | Birch | 10.9 inch d.b.h.; dead tree |
| 40 | Spruce | 10.3 inch d.b.h.; dead top |
| 42 | Spruce | 20.6 inch d.b.h.; large mechanical wound |
| 43 | Spruce | 11.5 inch d.b.h.; large mechanical wound |
| 59 | Hemlock | 14.2 inch d.b.h.; conks |
| 60 | Hemlock | 6.9 inch d.b.h.; |
| 61 | Spruce | 21.4 inch d.b.h.; conks; leaner |
| 62 | Spruce | 11.7 inch d.b.h.; bole canker |
| 65 | Spruce | 11.6 inch d.b.h.; forked tree; leaner |
| 68 | Birch | 15.9 inch d.b.h.; bole canker; conks; basal cavity |

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Reply to: 3400

Date: May 24, 1984

Mr. Tom Young
Chief Engineer
Design Construction
225 A Cordova
Anchorage, Alaska 99501

Dear Mr. Young:

On April 18 and 19, 1984, Tom Laurent, a Forest Pest Management Staff Pathologist from Juneau, and I examined the Bird Creek Campground at Mile 101.5 on the Seward Highway. The purpose of this visit, requested by Bill Evans, Alaska Division of Parks, was to identify pest problems which might be present; obtain an overview of stand conditions; identify and mark any trees which, in our opinion, provide a potential hazard to human health and property; and to offer suggestions for maintaining and/or improving site conditions within the campground.

The results of our investigations reveal that some pest problems are present in the campground tree cover. These include the spruce beetle, Dendroctonus rufipennis, and a number of root and stem decays in Sitka spruce, mountain hemlock and birch. Among these are brown cubical butt rot caused by Phaeolus schweinitzii; Indian paint fungus caused by Echinodontium tinctorium; and a white trunk rot caused by the fungus Fomes fomentarius. Probably several diseases are present in the birch, as this tree genus is host for several decay fungi.

The spruce beetle, a native insect, is always present in the white spruce and Sitka spruce forests of south-central Alaska. Mostly, beetle numbers are kept low by parasites, predators and by unfavorable weather conditions. Occasionally when conditions are just right this insect may suddenly increase in numbers and cause noticable tree killing. These conditions include an abundance of host material suitable for brood protection and warm, dry weather during late May and most of June.

Currently spruce beetle outbreaks occur on about 337,000 acres of forested lands in south-central Alaska. This includes about 226,000 acres in the Beluga Lake area on the west side of Cook Inlet; 12,000 acres in the Susitna River drainage near Devils Canyon; 40,000 acres on the Chugach National Forest and about 59,000 acres on the Kenai National Wildlife Refuge and adjacent forest land.

The spruce beetle found in the campground was all associated with trees that were slow growing, had suffered from root compaction, that had root and stem decay and that had suffered various forms of camper abuse. A major outbreak is not in progress. Only 13 infested trees were found. However, as long as environmental factors remain favorable, this insect will continue to peck away at the available host material.

Many trees in this campground have suffered from root compaction, construction damage and various forms of camper abuse. Overstocking in portions of the campground has undoubtedly contributed to between-tree competition. The average stand age, as determined by taking increment cores, is about 110 years. These cores reveal that individual tree growth rates have been declining over the past 20-25 years - probably coinciding with the increase in day-use and overnight camping. The ground cover in and around the heavily used units is nearly all gone, indicating an extremely heavy use pattern.

The spruce in this campground is vulnerable to the spruce beetle. Stands that are 100 years or older, with an average diameter of 10" or larger and a declining growth rate have been found to be most likely attacked by spruce beetle. The underlying causes of spruce beetle outbreaks are not yet well known. However, it has been observed that nearly all large outbreaks are associated with site disturbances that result in accumulations of debris suitable for brood development. The most common disturbances include blowdown, ice storm damage, clearing for land development and right-of-way clearing.

Other factors which predispose trees to spruce beetle include mechanical damage to root systems, soil compaction, severe and/or repeated bole scarying, root disease, and severe between-tree competition for space, nutrients, and moisture. The affects of any of these factors are greatly increased during periods of drought.

The stem and root decays observed are all fairly common in mature trees. Wind borne spores infect hosts through branch stubs, fire scars and wounded roots. Some spread may be associated with root contact between trees. The birch trees are especially vulnerable to the introduction of decay through wounding caused by campers.

Root diseases usually do not kill trees by themselves. Instead, as the infected tree gradually becomes weaker, it is more often attacked and killed by bark beetles or other insects, by other disease, or it may blow down. Some fungi can live as long as 50 years in the roots of infected stumps and trees.

Stress resulting from construction activities may turn a vigorous, though infected, tree into a weakened one in which the fungus gains dominance, eventually killing it. Or the tree may become susceptible to bark beetle or

borer attack. The movement of soil during construction, and with it infected roots in which the fungus can survive for long periods, is one way in which forest land development contributes to the spread and increase of some diseases.

Heart rot fungi colonize the non-living central core of trees. These fungi cause the decay of both heartwood and sapwood which results in a structural weakening of the stem and increases the likelihood of tree failure. Some of these fungi become evident when their fruiting bodies, called conks, protrude through the bark. The presence of a conk indicates that there is very little sound heartwood remaining. Any trees which contain visible conks should be removed from developed recreation sites.

Primary emphasis was placed on identification and marking of trees which were considered to be an obvious hazard to life or property in the campground or which were considered to have a high potential for failure. The identified hazards, marked with a spot of high visibility orange paint, include 30 birch, 33 spruce and 9 mountain hemlock trees. The majority of the 72 trees marked for removal were either dead, had dead tops, or were structurally weakened in some way. These included trees with a pronounced lean; rotted roots and/or many large dead limbs; obvious hollow trunks or which had visible evidence of internal decay. These included trees with large trunk scars (cat faces) and trees which had fruiting structures (conks) of decay fungi. The location of the hazard trees have been marked on a Department of Natural Resources site map with a scale of 1" = 100'. Included on the map are some suggestings for site improvement as well as the size, species, and approximate locations of individual trees.

The long-term use of a recreational site nearly always result in conditions which are unfavorable for the residual trees. Campground managers should, at least, be aware of the effects of camper abuse and root compaction in predisposing trees to invasion by bark beetles and a variety of diseases - suffice to say - healthy trees are seldom successfully attacked by either insects or disease. Some exceptions occur, but these mostly involve the invasion of plant material by exotic (introduced) insects and disease. The goal then is how to maintain plant cover while at the same time providing an outdoor adventure for a non-discerning public.

The problems associated with spruce beetle, and to some extent root diseases, can be largely prevented by avoiding conditions which are conducive to tree stress. Healthy, fast growing trees are usually not attacked by bark beetles or seriously affected by native tree diseases. For this reason it is considered good management to insure that trees are in as vigorous a state as possible. Some things that may be considered to accomplish this include fertilization and thinning or removing trees that are in a crowded condition. Fertilization will promote tree vigor and will stimulate some new root growth. This can be extremely important in older trees that have slow growth. Mature trees that are subjected to prolonged periods of drought - 30 days or more - often have a portion of their root system killed. When this occurs the tree has been placed in a state of physiological decline which

often results in bark beetle attack or root invasion by pathogens. Thinning of small groups of trees and the removal of crowded individuals will provide more water, nutrients and sunlight for the remaining individuals. This action will promote stand vigor; improve the general condition of individual trees; make the residual trees less vulnerable to the effects of suspected root pathogens; and insure a longer campground life.

Some site specific suggestions for improving this campground include the following:

1. Remove the identified hazard trees. This will reduce the possibility of tree failure which could result in personal injury and property damage. Removal of those high-hazard trees currently infested with spruce beetle will also reduce possibility of beetle buildup in campground.

2. Remove trees that have been heavily damaged by camper abuse or that have root damage as a result of previous construction or road building. These are trees that have a high probability of being infested by spruce beetle or of invasion by root and stem pathogens. Removing these trees now will minimize the need for hazard tree removal over a 10-15 year period of time. An additional benefit will be the improvement of vigor in surrounding residuals as a result of increased light, moisture and nutrients.

3. Rest-rotation of heavily utilized units. Close camping units in heavily compacted spruce stands and move to the lightly utilized birch stands. This will improve the vigor of the cathedral spruce, improve the overall aesthetics of the area, and reduce long-term pest problems.

4. Correct drainage problems. The only way to avoid additional tree mortality in the area of standing water near the north gate is to alter the drainage patterns and remove excess water (see attached site map). Methods may include ditching, installing culverts and/or drainage tiles.

5. Initiate a camper education program. Make campers and day users aware that their actions have either a positive or negative effect on the campground vegetation cover. Utilize the services of a campground host, if possible, post informative signs near damaged trees and closed units, and use the local news media where possible.

Some general suggestions for campground management include the following:

(1) Conduct a formal green hazard tree evaluation in all campgrounds for which you have responsibility. This inventory will provide you with site specific information which can be used objectively to make hazard assessments and implement measures designed to prevent accidents caused by tree failure.

(2) Develop a vegetation management plan for each campground and wayside. At a minimum this should include an objective and a prescription for maintaining the site in an aesthetically pleasing setting while at the same time creating durability and diversity.

Attached for your information is a brochure entitled "The Spruce Beetle in Alaska Forests"; a copy of a recent newspaper release entitled "Spruce Beetle, An Urban Pest"; a copy of a research paper entitled "Accident Hazard, Evaluation and Control Devisions on Forested Recreation Sites"; a reprint entitled "The Legal Implications of Hazards From Tree Disease and Related Factors in Recreation Areas"; a copy of a State of Washington, Department of Natural Resources publication entitled "Detection and Correction of Hazard Trees in Washington's Recreation Areas"; and a publication entitled "Your Tree's Troubles May Be You".

I hope that these comments and the supplemental information will be of value to you and your staff. Please contact me if you have any questions or comments concerning this evaluation.

The Forest Pest Management Staff Group is available to conduct biological evaluations; make green hazard tree surveys; assist in the development of vegetation management plans; and participate in or conduct training sessions. We may be contacted by calling 276-0939.

Donald J. Curtis

DONALD J. CURTIS
Group Leader, FPM

Enclosures

cc: Bill Evans
State Forester

# APPENDIX B

**VEGETATION COMPOSITION**
west-end birch stand

| SPECIES | | PLOT # 1 | 2 | 3 | 15 | 16 | AVG. |
|---|---|---|---|---|---|---|---|
| **TREES** | | | | | | | |
| Birch | | | | | | | |
| Mean Diameter (in) | | 5.2 | 5.2 | 5.7 | 6.5 | 5.2 | 5.6 |
| Basal Area (sq. ft./AC) | | 140 | 160 | 110 | 110 | 230 | 150 |
| Trees/AC < 1 inch | | 0 | 0 | 700 | 0 | 0 | 140 |
| Average Age | | 51 | 46 | / | 49 | 48 | 48 |
| Spruce | | | | | | | |
| Mean Diameter (in) | | / | / | 21.2 | 26.6 | 26.4 | 24.7 |
| Basal Area (sq. ft./AC) | | / | / | 30 | 10 | 10 | 17 |
| Trees/AC < 1 inch | | 700 | 500 | 1700 | 0 | 0 | 580 |
| **SHRUBS** | | --------- % cover --------- | | | | | |
| Echinopanax horridum | Devil's club | 1 | 5 | 2 | 15 | 10 | |
| Menziesia ferruginea | Rusty menziesia | 20 | 2 | 10 | | 75 | |
| Ribes hudsonianum | Black currant | | | | 50 | | |
| Ribes triste | Red currant | 1 | | 2 | | 5 | |
| Salix reticulata | Netleaf willow | | | | 5 | | |
| Sambucus racemosa | Elderberry | 1 | 2 | | | 2 | |
| Viburnum edule | Highbush cranberry | 5 | | 5 | | 2 | |
| **FORBS** | | | | | | | |
| Achillea borealis | Yarrow | 5 | | | 1 | | |
| Aruncus sylvester | Goatsbeard | | | 1 | | | |
| Cornus canadensis | Bunchberry | 1 | 2 | 1 | | 1 | |
| Epilobium angustifolium | Fireweed | 1 | | | | | |
| Galium triflorum | Sweet-scented bedstraw | 1 | | | | | |
| Pyrola secunda | Wintergreen | | 1 | | | | |
| Streptopus amplexifolius | Twisted stalk | | | | | 1 | |
| Trientalis europaea | Starflower | 1 | 1 | | 1 | 1 | |
| **GRASS AND GRASS-LIKE** | | | | | | | |
| | Grass | 5 | 30 | 50 | 75 | 2 | |
| **FERNS, HORSETAILS AND CLUBMOSSES** | | | | | | | |
| Athyrium filix-femina | Lady fern | | | | 2 | | |
| Dryopteris dilatata | Wood fern | 10 | 10 | | 2 | 2 | |
| Equisetum arvense | Common horsetail | | | | 1 | | |
| Lycopodium annotinum | Stiff club moss | 15 | 1 | 1 | | | |

## VEGETATION COMPOSITION
east-end ecotone

| SPECIES | | PLOT # 12 | 13 | 14 | AVG. |
|---|---|---|---|---|---|
| **TREES** | | | | | |
| Birch | | | | | |
| Mean Diameter (in) | | 5.2 | 4.6 | 6.4 | 5.4 |
| Basal Area (sq. ft./AC) | | 100 | 150 | 160 | 134 |
| Trees/AC < 1 inch | | 0 | 0 | 0 | 0 |
| Average Age | | 52 | 44 | 53 | 50 |
| Spruce | | | | | |
| Mean Diameter | | / | / | / | / |
| Basal Area (sq. ft./AC) | | / | / | / | / |
| Trees/Ac < 1 inch | | 100 | 400 | 600 | 367 |
| **SHRUBS** | | -- % cover --- | | | |
| Echinopanax horridum | Devil's club | 1 | | | |
| Menziesia ferruginea | Rusty menziesia | 1 | 1 | | |
| Ribes triste | Northern red current | 5 | | | |
| Sambucus racemosa | Elderberry | 5 | | | |
| Spiraea beauverdiana | Beauvered spiraea | | | 1 | |
| **FORBES** | | | | | |
| Achillea borealis | Yarrow | | 1 | | |
| Cornus canadensis | Bunchberry | 1 | 25 | 1 | |
| Epilobium angustifolium | Fireweed | 1 | | | |
| Rubus pedatus | Fiveleaf bramble | 1 | | 2 | |
| Trientalis europaea | Starflower | 1 | 1 | 1 | |
| **GRASS AND GRASS-LIKE** | | | | | |
| GRASS | | 25 | | 5 | |
| **FERNS, HORSETAILS AND CLUBMOSSES** | | | | | |
| Athyrium filix-femina | Lady fern | | | 5 | |
| Dryopteris dilatata | Wood fern | 5 | 1 | 5 | |
| Gymnocarpium dryopteris | Oak fern | | | 75 | |
| | Moss | 5 | 5 | | |

## VEGETATION COMPOSITION

main campground spruce stand

| SPECIES | PLOT # 4 | 5 | 6 | 7 | 8 | AVG |
|---|---|---|---|---|---|---|
| **TREES** | | | | | | |
| Spruce | | | | | | |
| Mean Diameter (in.) | 19.0 | 17.5 | 23.6 | 13.6 | 18.0 | 18.3 |
| Basal Area (sq. ft./AC) | 220 | 190 | 150 | 330 | 250 | 228 |
| Trees/Ac < 1 inch | 0 | 0 | 0 | 0 | 0 | 0 |
| Average Age | 122 | 120 | 108 | / | / | 117 |
| Hemlock | | | | | | |
| Mean Diameter (in.) | 0 | 14.0 | 15.0 | 0 | 0 | 14.5 |
| Basal Area (sq. ft./AC) | 0 | 20 | 10 | 0 | 0 | 6 |
| Trees/AC < 1 inch | 0 | 0 | 0 | 0 | 0 | 0 |
| Average Age | 0 | 120 | / | 0 | 0 | 120 |
| **SHRUBS** | -------- % cover -------- | | | | | |
| Menziesia ferruginea Rusty menziesia | 1 | | 15 | | 2 | |
| **FERNS, HORSETAILS AND CLUBMOSSES** | | | | | | |
| Moss | 1 | 1 | 2 | 1 | | |

## SOIL COMPACTION DATA

MEAN TONS/SQ.FT.

| | | | | | | |
|---|---|---|---|---|---|---|
| Surface | 2.3 | 3.3 | 2.8 | 2.6 | 3.1 | 2.8 |
| Mineral | 3.3 | 2.9 | 2.5 | 2.8 | 2.5 | 2.8 |

## VEGETATION COMPOSITION
undisturbed spruce stand

| SPECIES | | PLOT # 9 | 10 | 11 | AVG. |
|---|---|---|---|---|---|
| **TREES** | | | | | |
| Spruce | | | | | |
| Mean Diameter (in.) | | 16.8 | 14.2 | 16.5 | 15.8 |
| Basal Area (sq. ft./AC) | | 200 | 120 | 120 | 147 |
| Trees/AC < 1 inch | | 0 | 0 | 5100 | 1700 |
| Average Age | | 112 | 135 | 125 | 124 |
| Hemlock | | | | | |
| Mean Diameter (in.) | | 0 | 16.6 | 16.7 | 16.7 |
| Basal Area (sq. ft./AC) | | 0 | 30 | 10 | 13 |
| Trees/AC < 1 inch | | 0 | 0 | 53100 | 17700 |
| Average Age | | / | / | / | / |
| **SHRUBS** | | -- % cover -- | | | |
| Vaccinium vitis-idaea | Lowbush cranberry | 1 | | | |
| **FORBS** | | | | | |
| Cornus canadensis | | 1 | | | |
| Geocaulon lividum | Northern comandra | | | 2 | |
| Pyrola chamaemorus | Cloudberry | 1 | | | |
| Rubus pedatus | Fiveleaf bramble | 5 | | 1 | |
| **FERNS, HORSETAILS AND CLUBMOSSES** | | | | | |
| | Moss | 90 | 60 | 40 | |

## SOIL COMPACTION DATA
MEAN TONS/SQ.FT.

| | | | | |
|---|---|---|---|---|
| Surface | 1.0 | 1.0 | 1.0 | 1.0 |
| Mineral | 1.2 | 1.3 | 1.1 | 1.2 |

# APPENDIX C

NOTES ON PLANT SPECIES PRESENT AS SIGNIFICANT GROUNDCOVER

***SHRUBS***

Echinopanax horridum, devil's club
- *shade tolerant
- *spreads vigorously
- *transplant small plants
- *thorny; good traffic director

Menziesia ferruginea, rusty menziesia
- *shade tolerant
- *propigate from seed, stem cuttings, transplants
- *spreads by runners

Ribes hudsonianum, northern black currant
- *shade tolerant
- *propagate from seed, transplants, stem cuttings
- *unpleasant odor when leaves or berries crushed; traffic director
- *bird food and cover

Ribes triste, red currant
- *shade tolerant
- *propagate from seed, transplants, stem cuttings
- *bird food and cover

Sambucus callicarpa, pacific red elder
- *better in more open areas
- *propagate from seedlings and transplants, stem cuttings
- *unpleasant odor when leaves crushed; traffic director
- *bird food and cover

Spirea beaverdiana, spirea
- *marginal in area
- *propagate from seed, seedlings and transplants, stem cuttings

***LOW GROUNDCOVERS***

Salix reticulata, net leaf willow
- *creeping shrub
- *better for sunny spots
- *propagate from seed, stem or root cuttings
- *transplant in mats or plugs

Achillea borealis, yarrow
- *aggressive perennial, sometimes considered a weed
- *can take foot traffic

Cornus canadensis, bunchberry, ground dogwood

*can be difficlt to establish
*not very tolerant to heavy foot traffic
*propagate from seed, seedlings and transplants, or root cuttings
*try transplanting in mats or plugs
*shade tolerant
*source of bird food

Rubus pedatus, five-leaf bramble
*often found with moss
*propagate from seed, seedlings and transplants, stem or root cuttings
*transplant as mats or plugs, beneath shrubs

Lycopodium annotinum, stiff club moss
*may be difficult to establish
*try mats or plugs for transplants

Dryopteris dilatata, wood fern
*shade tolerant
*propagate from transplants
*will not withstand foot traffic

Athyrium filix-femina, lady fern
*shade tolerant
*propigate from transplants
*will not withstand foot traffic

Gymnocarpium dryopteris, oak fern
*shade tolerant
*propagate from transplants
*intolerant of foot traffic